

A.1.2 Research in Exobiology

1. Scope of Program

The goal of NASA's Exobiology Program is to understand the origin, evolution, and distribution of life in the universe. Research is focused on achieving this goal by tracing the pathways taken by the biogenic elements, leading from the origin of the universe through the major epochs in the evolution of living systems and their precursors. These epochs (and the approximate percentage of funding historically allocated to each) are: the cosmic evolution of the biogenic compounds (15%); prebiotic evolution (35%); the early evolution of life (35%); and the evolution of advanced life (15%).

The principal goal of research in the area of the cosmic evolution of the biogenic compounds is to determine the history of the biogenic elements (C, H, N, O, P, S) from their birth in stars to their incorporation into planetary bodies. Emphasis is placed on studies that constrain or extend concepts of possible chemical evolution relevant to the origin, evolution, and distribution of life.

- Research in the area of prebiotic evolution seeks to understand the pathways and processes leading from the origin of a planet to the origin of life. The strategy is to investigate the planetary and molecular processes that set the physical and chemical conditions within which living systems arose. Four major objectives are to: i) determine constraints on prebiotic evolution imposed by the physical and chemical histories of planets; ii) develop models of active boundary regions in which chemical evolution could have occurred; iii) determine what chemical systems could have served as precursors of metabolic and replicating systems both on Earth and elsewhere; and iv) determine in what forms prebiotic organic matter has been preserved in planetary materials.

The goal of research into the early evolution of life is to determine the nature of the most primitive organisms, the environment in which they evolved, and the way in which they influenced that environment. As an approach to understanding life in the universe, the opportunity is taken to investigate two natural repositories of evolutionary history available on Earth, in particular, the molecular record in living organisms and the geological record in rocks. These paired records are used to: i) determine when and in what setting life first appeared; ii) determine the characteristics of the first successful living organisms; iii) understand the phylogeny and physiology of microorganisms thought to be analogs of primitive environments; iv) determine the original nature of biotic energy transduction, membrane function, and information processing through study of extant microbes; and iv) elucidate the physical, chemical, and biotic forces operating on microbial evolution.

- The research associated with the study of the evolution of advanced life seeks to determine the extrinsic factors influencing the development of advanced life and its potential distribution. This research includes an evaluation of the influence of extraterrestrial and planetary processes on the appearance and evolution of multicellular life, conducted by: i) tracing the effects of major changes in the Earth's environment on the evolution of complex life, especially during mass extinction events, and ii) determining the effects of global events and of events originating in space on the production of environmental changes that affected the evolution of multicellular life. Also, studies will be considered that would seek approaches to investigations furthering our understanding of the distribution of life elsewhere in the universe.

The severe constraints of weight and volume on payloads and the unique nature of some potential exobiological investigations necessitates novel concepts for flight instrumentation to maximize the scientific return of future missions. Therefore, included in the scope of the Exobiology Program is the development of advanced instrument concepts and technologies that may enable exobiology research in space exploration, for which additional funding is available. Beyond advanced instrument concepts the Planetary Instrument Definition and Development Program (PIDDP; Section A.3.5 in Appendix A of this NRA) supports the development of exobiology instruments through the breadboard stage. Funds are available under the PIDDP to provide for upgrading of analytical instruments required by investigations sponsored by the Exobiology Program.

In addition, proposals for new, major analytical instrumentation that is necessary for the conduct of proposed exobiology research, or that would substantially improve its quality, may be submitted through the provisions of the Planetary Major Equipment Program; see Section A.3.6 of Appendix A of this ROSS NRA.

2. Programmatic Information

Proposals are sought for new projects within the scope of the Exobiology Program. Proposals submitted in response to this NRA should be for work that is not currently supported by the Exobiology Program, as well as tasks that are currently funded in the Exobiology Program but whose periods of performance are expiring in 1998 or in the first half of 1999. Periods of performance from one to five years (typically three years) may be proposed, as appropriate to the nature of the contemplated research. Proposers are reminded that programmatic balance (see historical percentages above) may limit the opportunities for funding in some areas.

The Exobiology Program usually competes one third of the program every year, and so it is anticipated that approximately \$3M will be available to support research proposed in response to this NRA.

Progress reports for the annual funding allotment to complete the second or subsequent years of previously approved multiple year awards will be considered separately and should be sent directly to the Exobiology Program Discipline Scientist (see below) at least 90 days before their funding anniversary date.

The schedules for submission of the Notice of Intent and proposal are given in Table 1 of the cover letter of this NRA. The World Wide Web site for submitting both the NOI and the *Cover Page/Proposal Summary* (see Appendix C.5.3) is

<<http://cass.jsc.nasa.gov/panel/>>; proposers without access to the Web or who experience difficulty in using this site may contact the Lunar Planetary Institute by E-mail at <panel@lpi.jsc.nasa.gov> or by phone at (281)486-2156 or -2166 for assistance. Hard copies of the proposals are to be delivered to:

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Research in Exobiology

The Lunar and Planetary Institute

3600 Bay Area Boulevard

Houston, TX 77058

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Obtain additional information from the Discipline Scientist:

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